Available online at www.sciencedirect.com
SciVerse ScienceDirect
Systems Engineering Procedia 2 (2011) 324 – 330
Procedia Systems Engineering

Research on portfolio optimization of agricultural intellectual property promotion engineering projects

Wanli Ma*

China Jiliang University, Hangzhou 310018, P.R.China

Abstract

Venture capital which supports the commercialization of agricultural S&T achievements is a new type of investment mode. High earning of agricultural intellectual property venture capital coincides with high risk. How to balance the return on investment against the risk of investment and how to decide the compositions of investment portfolios are what the investment companies most concern. From the perspective of venture capital companies, this paper, which applies expert evaluation method, mean-variance portfolio theory and quadratic programming, studies optimization of intellectual property venture portfolio, proves rationality and feasibility of the model through case analysis, and provides a theory for venture capital companies to optimize their investment portfolios.

Keywords: Venture capital; Agricultural intellectual property; Promotion engineering projects; Portfolio optimization; Quadratic programming

1. Introduction

Agricultural intellectual properties include patents, trademarks, products of place of origin (geographic indication) and the new varieties of plants, etc. The industrialization of agricultural intellectual property needs Venture capital which has become a new type of investment mode to supports the commercialization of agricultural intellectual property. Venture capital plays a more and more important role to promote agricultural high-tech development. Agricultural intellectual property venture Capital has high earnings, coincided with a high risk. How to balance the returns from investments against the risks that may result from them and how to decide the compositions of investment portfolios are what the investment companies most concern. Researches on investment portfolio done by the scholars of China and other countries can be divided into two categories in general:

First, classic investment portfolio theory established on the basis of strict premise and hypothesis. Starting from the study on the relationship between the return rate and the risk arising from risky assets, Harry Markowitz (1952) describes risk with variance and discusses on selection of the optimal asset portfolio in the Uncertain Economic System. Under efficient markets hypothesis, Sharpe William F (1964) and Linter John (1965) suggested balanced Markowitz's model of mean-variance , i.e. capital asset pricing model (CAPM). Ross (1976) made breakthrough in progressing capital asset pricing theory and put forward the Arbitrage Theory of Capital Asset Pricing.

Second, classic investment portfolio theory is built on basis of strict hypothesis, which is where some scholars found it imperfect. Therefore, many innovative models and corrective models kept springing up. Vesa Kanniainen

* Corresponding author. Tel.: +86-0571-87676270; fax: +86-0571-87633580.
E-mail address: mawlrq@126.com

doi:10.1016/j.sepro.2011.10.045

(2003) has innovated the model for investment portfolio. They believed that the consultation strength should be weighed against investment portfolio for venture capitalists to provide enterprises with consultation services. Liu Shuren et al. (2004) worked out the indifference curve by applying the Principle of Effective Selection of asset portfolio to the double curve depicted on the σ-γ plane used for describing the effective frontier of the mean-variance model and then the optimal investment portfolio in terms of effective function. Gao Junjun et al. (2006) proposed the model for measurement of the utilities from the investments by the venture capital companies. On the basis of the analysis on return and risk, Xu Yonglong et al. (2008) established return and risk optimization model by measuring risks with semi-variance, overcoming shortcomings of past research. Chen Guohua (2010) studied the multi-objective securities portfolio investment model. It can be found in the literature dealing with the investment portfolio written by Chinese or foreign scholars which are mentioned above, that most researches, whether Chinese or foreign, focus on the Least-squares Algorithm by Markowitz, CAPM model by Sharpe and Linter and many other corrective and innovative models coming up later one after another, which constitutes the major parts of model investment portfolio theory. However, these investment portfolio models are more used in stocks, funds, futures and other investment means than in the research on the agricultural intellectual property venture.

2. Construction of the model for portfolio optimization of Agricultural intellectual property venture capital projects

2.1 Basic hypothesis

From the perspective of venture capital companies, two interrelated objectives are involved in an investment: first, security; and second, profitability. This paper studies how to achieve the maximum expected investment return with the least investment portfolio risk, with security targets represented by investment portfolio risks and profitability by expected returns from investment.

To facilitate my study, the following hypotheses are proposed in this paper:

First, suppose both venture capital companies and investment experts have learnt so much market information that expected return and variance from each venture capital project can be worked out through expert evaluation method.

Second, suppose that venture capital companies aim their investments either at maximizing returns under given risks or at minimizing their risks under given returns.

Third, the reciprocal relationship between the returns from different investment projects can be described with correlation coefficient.

Fourth, suppose that venture capital companies pay attention only to investment returns and risks from investments in making investment-related decisions.

2.2 Construction of the model involving only one investment project

The expected return from a certain investment can not be exactly figured out and according to mean-variance investment portfolio theory, the classic theory proposed by H.Markowitz, a U.S economist, this paper believes that investment expectation return of risky investment can be described by sample mean (expectation):

$$E(x) = (x_1 + x_2 + ... + x_n) / n = \sum_{i=1}^{n} x_i / n \qquad (2.1)$$

where x_i is the grade given by *i*th expert, as an evaluation by the expert on expected return of the investment project; $\bar{x}$ is expected return of investment project; n represents number of experts.

Expected return from an investment describes average profitability out of the investment. However, it is not enough to describe investment effect only with expected return of investment; also it is necessary to measure the tendency of dispersion to describe rise and fall of data, i.e. the size of risks. Typically, the dispersion tendency of a group of expected investment return $(x_1, x_2, ..., x_n)$ is measured with the variance, calculated in the following equation, and the standard deviation.

$$\sigma^2 = \sum_{i=1}^{n} (x_i - \bar{x})^2 / (n-1) \tag{2.2}$$

Here, σ^2 can be considered as variance of expected investment return; x_i is the point given by *i*th expert; $\bar{x}$ is expected return of the investment project; n represents the number of the experts. To extract the square root of the variance, we will find standard deviation of relative investment effect. Hence:

$$\sigma = (\sum_{i=1}^{n} (x_i - \bar{x})^2 / (n-1))^{1/2} \tag{2.3}$$

Here, σ is the standard deviation of expected investment return.

2.3 Multi investment projects model construction

Model construction extends from the above single investment project model to multi investment project model.

As for investment involving more than one project, expected return depends on not only the expectation from each constituent but also the proportion of each constituent to the investment as a whole. The expectation of a single project constituting an investment portfolio composed of m investment projects are respectively $\mu_1, \mu_2, ...\mu_m$, and their investment proportions are respectively $w_1, w_2, ..., w_m$, then the expected return from the investment portfolio is the sum of products of expectation from a single project and the investment proportion corresponding to the expectation. Hence,

$$E(R) = w_1\mu_1 + w_2\mu_2 + ... + w_m\mu_m \tag{2.4}$$

Here, E(R) is the total expected return from the investment portfolio; $\mu_1, \mu_2, ...\mu_m$, are the expected returns from No.1 to No m projects; $w_1, w_2, ..., w_m$, are the proportions of No.1-No m projects.

The total expected return from the investment portfolio describes overall average profitability of the investment involving more than one projects. Meanwhile, it is not enough to describe the effect of an investment portfolio only with total expected return; we need description of its dispersion tendency, i.e. size of the overall risk in investment portfolio. The overall risk accompanying the overall expected return from an investment portfolio is measured with the variance and standard deviation of the overall expected return. The variance of the overall expected return depends on the following factors:

The first is the variance of the expected return from a single investment project, for the greater it is, the higher the variance of the overall expected return from the investment portfolio;

The second is the proportion of the size of each project to that of the investment portfolio as a whole. The greater it is, the larger effect the project has on the risk in the investment portfolio;

Third, correlation between all investment projects, risk of an investment project may have effect on the risk in another investment project and then the overall investment portfolio.

The variance of the overall expected return from an investment portfolio is calculated in the following equation:

$$\sigma'^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + ... + w_m^2\sigma_m^2 + \sum_{i \neq j} w_i w_j \rho_{ij} \sigma_i \sigma_j \tag{2.5}$$

Here σ' is standard deviation of general expected investment return;

$w_1, w_2, ..., w_m$, are proportions of the 1st to the *m*th project;

$\sigma_1^2, \sigma_2^2, ..., \sigma_m^2$, are variances of expected returns from the 1st to the *m*th investment projects;

$\sigma_1, \sigma_2, ...\sigma_m$ are standard deviation of expected returns from the 1st to the *m*th investment projects ;

ρ_{ij} is correlation coefficient of the *i* th venture capital project and the *j*th venture capital project.

The right side of equation (2.5) is composed of two parts: one is $w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + ... + w_m^2\sigma_m^2$, which means the sum of products of square proportion of each investment projects and the variance of expected return from the projects. It shows that the overall variance depends on single variance and the proportion of each investment project. Another one is $\sum_{i \neq j} w_i w_j \rho_{ij} \sigma_i \sigma_j$, which shows that the overall variance depends on correlations between all venture capital projects. When correlation coefficient, $\rho_{ij} = 0$, i.e. the *i*th venture capital project is uncorrelated to the *j*th venture capital project, the value of the second part is zero; when correlation coefficient, ρ_{ij} is other value than 0, the correlation between the venture capital projects will allow the risk in the *i*th venture capital project to have effect on the risk in the *j*th venture capital project and then on the risk in the overall investment portfolio. Where, when $\rho_{ij} > 0$, i.e. increase of the *i*th venture capital project will raise the risk in the *j*th project, known as positive correlation, and thus lead to the increase of the risk in the overall investment portfolio. Otherwise, when $\rho_{ij} < 0$, i.e. increase in the *i*th venture capital project will reduce the risk in the *j*th project, known as negative correlation, and thus lead to the decrease of the risk in the overall investment portfolio.

In conclusion, the investment effect of a venture capital projects portfolio can be described with the expectation and variance from the overall investment portfolio, the former representing the expected return from the investment portfolio and the latter the overall risk in the investment portfolio, i.e. the security.

2.4 Construction of intellectual property venture capital project portfolio optimization model

As we all know, most of the intellectual property venture capital companies aim their investment at maximizing return from their investments while minimizing the risks in their investments .A portfolio optimization model is established to determine the optimal ratios of the constituents in an investment portfolio and maximize the overall expected return from the investment portfolio, i.e. to gain the most profits, with the variance of level of the total investment effect of the investment portfolio controlled under an acceptable value; or ; minimize the variance of the level of the total investment effect from the investment portfolio, with the overall expected return from the investment portfolio not lower than a required value.

The measurements abovementioned of the return and risk from an investment involving more than one projects shows that venture capital companies set up models for optimization of venture capital combination by firstly figuring out the expectation and variance from the investment to forecast expected return from the investment portfolio. And determining the optimal proportions of each investment project to the investment portfolio as a whole applying the Quadratic Programming Theory, a method in operational research.

According to Section 2.3, we can work out mean value of expected investment returns from all venture capital projects, namely:

$$\bar{x}_j = \frac{1}{n} \sum_{i=1}^{n} x_{ij}, j = 1,2,...m \tag{2.6}$$

Here $\bar{x}_j$ represents the *j*th expected investment return of the venture capital project; m means that there are *m* venture capital projects in total; n means experts number;

Investment portfolio risk, which means the variance of the general investment expectation of the portfolio, can be described as follows:

$$\sigma^2 = \sum_{j=1}^{n} w_j^2 \sigma_j^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \rho_{ij} \sigma_i \sigma_j, \quad where\ i \neq j \tag{2.7}$$

and σ^2 means risk of investment portfolio;

$\sum_{j=1}^{n} w_j^2 \sigma_j^2$ means products of single variance and investment proportion;

$\sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \rho_{ij} \sigma_i \sigma_j$ means correlation between all venture capital projects;

w_i, w_j respectively means the proportion of investment provided by a venture capital company to i and j projects to its total amount of investment; hence,

$$\sum_{i=1}^{n} w_i = 1 \tag{2.8}$$

In conclusion, to minimize risks, a venture capital company must allow

$$\min \sigma^2 = \sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \rho_{ij} \sigma_i \sigma_j \text{ , where } i \neq j$$

$$\left.\begin{aligned} & s.t. \sum_{i=1}^{n} w_i \bar{x}_i \geq x_0 \\ & \sum_{i=1}^{n} w_i = 1 \\ & w_i \geq 0, i = 1, 2, \ldots n \end{aligned}\right\} \tag{2.9}$$

Here x_0 is the minimum expected investment return from the investment project portfolio required by the venture company.

To maximize profits, a venture capital company must allow:

$$\max X = \sum_{i=1}^{n} w_i \bar{x}_i$$

$$\left.\begin{aligned} & s.t. \sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \rho_{ij} \sigma_i \sigma_j \leq \sigma_0^2 \text{ , in which } i \neq j \\ & \sum_{i=1}^{n} w_i = 1 \\ & w_i \geq 0, i = 1, 2, \ldots n \end{aligned}\right\} \tag{2.10}$$

Here σ_0^2 is the maximum portfolio risk the venture company can tolerate.

3. Case study

Sampling Chenguang Biotech Group Co.,Ltd. and other 10 newly founded companies, which own agricultural intellectual property projects and need venture capital, we have invited 20 experts for comprehensive evaluation of these optional intellectual property projects using Expert Evaluation Method (by 5-Point System, i.e. from 1 point to 5 points),in market, technology, corporate management team, finance and environment. We ranked these enterprises by their expected investment return, high to low, three projects were selected as the most valuable for investment, and they are projects of Kam Rice of China, lentils safety quality breeding and Chenguang biotechnology. Then we respectively worked out their means and variances of expected investment return, as shown in the following table:

Table 3.1 Means and Variances of the Projects' Investment Expectations

	Projects of Kam Rice of China	Projects of lentils safety quality breeding	Chenguang biotechnology

Mean of expected investment return	4.085	3.607	3.569
Variance of expected investment return	0.0271	0.02318	0.2443

As the three enterprises are irrelated to each other, $\rho_{ij} = 0$ thus $\sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j \rho_{ij} \sigma_i \sigma_j = 0$.

Suppose venture companies are pursuing risk minimization and let u represent minimum expected investment return they require, where value of u is 3.6 (based on the average expected return value of project evaluations by experts in the past years), hence we obtained the model for optimization of investment portfolio as follows:

$$\min \sigma^2 = \sum_{i=1}^{n} w_i^2 \sigma_i^2 = w_1^2 * 0.02318^2 + w_2^2 * 0.0271^2 + w_3^2 * 0.2443^2$$

$$\left.\begin{aligned} & s.t. \sum_{i=1}^{3} w_i \bar{x}_i = w_1 * 3.607 + w_2 * 4.085 + w_3 * 3.569 \geq 3.6 \\ & \sum_{i=1}^{3} w_i = 1 \\ & w_i \geq 0, i = 1, 2, 3 \end{aligned}\right\} \qquad (3.1)$$

To solve the model, we get $w_1 = 0.3, w_2 = 0.7, w_3 = 0$, $\min \sigma^2 = 0.005$. Risk in the investment portfolio is 0.005<0.05 (the maximum risk tolerance of the venture company), so it is within the tolerance range of the venture company. Suppose the amount applicable by the venture capital company is CNY 20 million, and according to the proportions for the constituents in the investment portfolio, hence we get the funds distribution of the two venture enterprises as follows:

Table 3.2 Distribution Results of Venture Capital

Name of company	Project of lentils safety quality breeding	Project of Kam Rice of China
Distribution result	RMB 6 million	RMB 14 million

With RMB 20 million to invest in agricultural intellectual property projects, the venture capital company can obtain the average of the expected returns in the past few years and minimize investment risks by spending RMB 14 million in project of Kam Rice of China and RMB 6 million in project of lentils safety quality breeding.

4. Conclusion

This paper studies how to optimize venture capital project portfolio through expert evaluation method, mean-variance portfolio theory and quadratic programming and explains rationality and feasibility through sample analysis to provide theoretical reference for venture companies to optimize venture capital project portfolio. Certainly, agricultural intellectual property venture project portfolio optimization is a dynamic process with stages involved. Besides investment volume and proportions of the funds invested in different projects, we shall also consider investment and withdrawal schedule, all of which want further research in future.

5. Copyright

All authors must sign the Transfer of Copyright agreement before the article can be published. This transfer agreement enables Elsevier to protect the copyrighted material for the authors, but does not relinquish the authors' proprietary rights. The copyright transfer covers the exclusive rights to reproduce and distribute the article, including reprints, photographic reproductions, microfilm or any other reproductions of similar nature and translations. Authors are responsible for obtaining from the copyright holder permission to reproduce any figures for which copyright exists.

Acknowledgements

This paper is sponsored by "Key Universities Research Institute of Humanities and Social Sciences in Zhejiang Province——Standardization and Intellectual Property Management".

References

1. Markowitz H, Portfolio selecting. Journal of Finance.1(1952) 77-91.
2. Sharpe and William F, Capital asset prices: A theory of market equilibrium under conditions of risk. Journal of Finance.19(1964) 58-72.
3. Linter and John, The valuation of risk asset sand the selection of risky investments in stock portfolios and capital budges. Review of economics and statistics. 47(1965) 63~84.
4. Ross S A, The arbitrage theory of capital asset pricing. Journal of Economic theory.3 (1976) 341-360
5. Vesa Kanniainen and Christian Keuschnigg, The optimal portfolio of start-up firms in venture capital finance. Journal of Corporate Finance,.9 (2003) 521~534.
6. Shuren Liu and Xuemei An, The Portfolio Investment Decisions about Exponent Utility. Journal of Xiangtan Normal University. 2 (2004) 94-97.
7. Junjun Gao, Lejiang Hu and Dehui Pan, Optimal Model on Investment Combination of Venture Capital Firm. Journal of Systems Engineering. vo1.21 No.1(2006) 68-74.
8. Yonglong Xu and Liang Zhao, On Optimal Model of Portfolio Investment. Journal of Tianjin University of Commerce. 2 (2008) 3-6.
9. Guohua Chen, The ideal point method of Many target portfolio model. Journal of Hunan University of Technology. (12010) 47-56.